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High Fluence 1ω Performance Test using 20 ns Ignition Shaped Pulses on the Beamlet Prototype Laser

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A full scale, single-aperture scientific prototype of the National Ignition Facility (NIF) laser driver, called Beamlet, has been operated at LLNL since 1993. The goal of the Beamlet is to validate the laser physics design basis of the NIF driver. During its operation, Beamlet has demonstrated the laser architecture and components required to build a compact, multipass cavity amplifier operating close to its expected performance limits, based on optical component damage thresholds and beam modulation. At the design point, Beamlet was operated at 13.5 J/cm^2 in a 3 ns square output pulse, generating over 13 kJ in a 34 cm by 34 cm beam. The highest energy performance at 1ω was demonstrated using a 10 ns square output pulse, with 17.3 kJ in a 35 cm by 35 cm beam (16.6 J/cm^2) approaching the amplifier

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stored energy extraction limit. Beamlet's high fluence performance is slightly lower than the NIF design because it has two fewer slabs in the final amplifier section compared to the NIF lay-out.

Performance limitations due to nonlinear effects at the end of a long saturating pulse have recently been validated by short pulse experiments and modeling using actual phase maps of Beamlet components. Operating conditions that maintain a sufficient margin against damage by small-scale-self-focusing have been established. Contamination of sol-gel coatings has been recognized as a damage threat at Beamlet fluence levels, and has subsequently been eliminated by maintaining clean transport filter vessels.

An integrated optical modulator typically provided exponential pulse shaping with a contrast of up to 17:1 to obtain square output pulses with a maximum duration of 10 ns. Using a NIF prototype of the computer controlled system to provide temporal pulse shaping and a modified ring regenerative amplifier, arbitrarily shaped 20 ns pulses can be generated and amplified. We will present experimental results and modeling of the laser performance and beam quality evaluation using the nominal NIF pulse shape for indirect drive ignition, also called the Haan pulse. It consists of a 17 ns long foot and a 3 ns main pulse, with an equivalent pulse duration of 4.5 ns. A preliminary evaluation of pinhole ablation and closure effects in the spatial filters related to the increased pulse duration will also be presented.